By Centre for Environment and Climate Action

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Climate, Connectivity and Cooperation:

A New Altitude in a Warming World

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Introduction

At the same time, they are at the frontline against climate change, whose cascading effect could open the Pandora's box for the world thereafter.

The Arctic region and the Hindu Kush Himalayan range are miles apart. Yet, there is hardly any contrast between these two regions; their pristine natural features, all-time sensitive ecosystems and a myriad of evidence that could unlock answers to some of the pressing issues about the changing geological and historical dynamics of our planet. At the same time, they are at the frontline against climate change, whose cascading effect could open Pandora's box for the world thereafter.

Not only that, human actions elsewhere have also aggravated the situation. An acknowledgement of the importance of these cryospheres is the need of the hour to not just mitigate the risk of climate change but also keep them up and running to secure the future of humanity.

The Artic Climate

As a result, warm air flows towards the Arctic and cold air flows away to other parts of the world which defines the pattern for daily weather across the world.

Subservience to Changing Winds: Scientific Description of the Regions

With less sea ice, ocean water gets exposed to solar radiation which will absorb more heat and melt more of such sea ice.

Arctic Region– The Cool Rooftop

Lying above 66.5° north of the Equator, the Arctic region possesses year-round ice at various places. Some of them include the vast Greenland ice sheet, ice caps at the Canadian Arctic Cordillera and the year-round ice sea near the pole in the Arctic Ocean. Due to Earth's axial tilt, solar radiation is not as intense as it would have been elsewhere. Thus, the region has a tundra climate with brisk summers, low precipitation and long winters with paltry flora and fauna and thus a sparse human population.

As a result, warm air flows towards the Arctic and cold air flows away to other parts of the world which defines the pattern for daily weather across the world. Moreover, the heat gain of the rest of the world gets balanced out by the heat loss in the Arctic, making it known as the 'heat sink' of the world. This is consequential; with a perpetual rise in temperatures, sea ice could melt more than expected. With less sea ice, ocean water gets exposed to solar radiation which will absorb more heat and melt more of such sea ice. Not only that, thawing of permafrost has resulted in the generation of greenhouse gases further exacerbating the climate change risk.[1]

However, researchers, even after studying the region, remain in the dark about the mysteries it beholds. Some of them have postulated that positive feedback can arise. For example, thawing of permafrost could make conducive conditions for flora to thrive which could thus absorb more carbon dioxide. Nevertheless, whether such positive feedback could outweigh negative feedback is yet to be ascertained.

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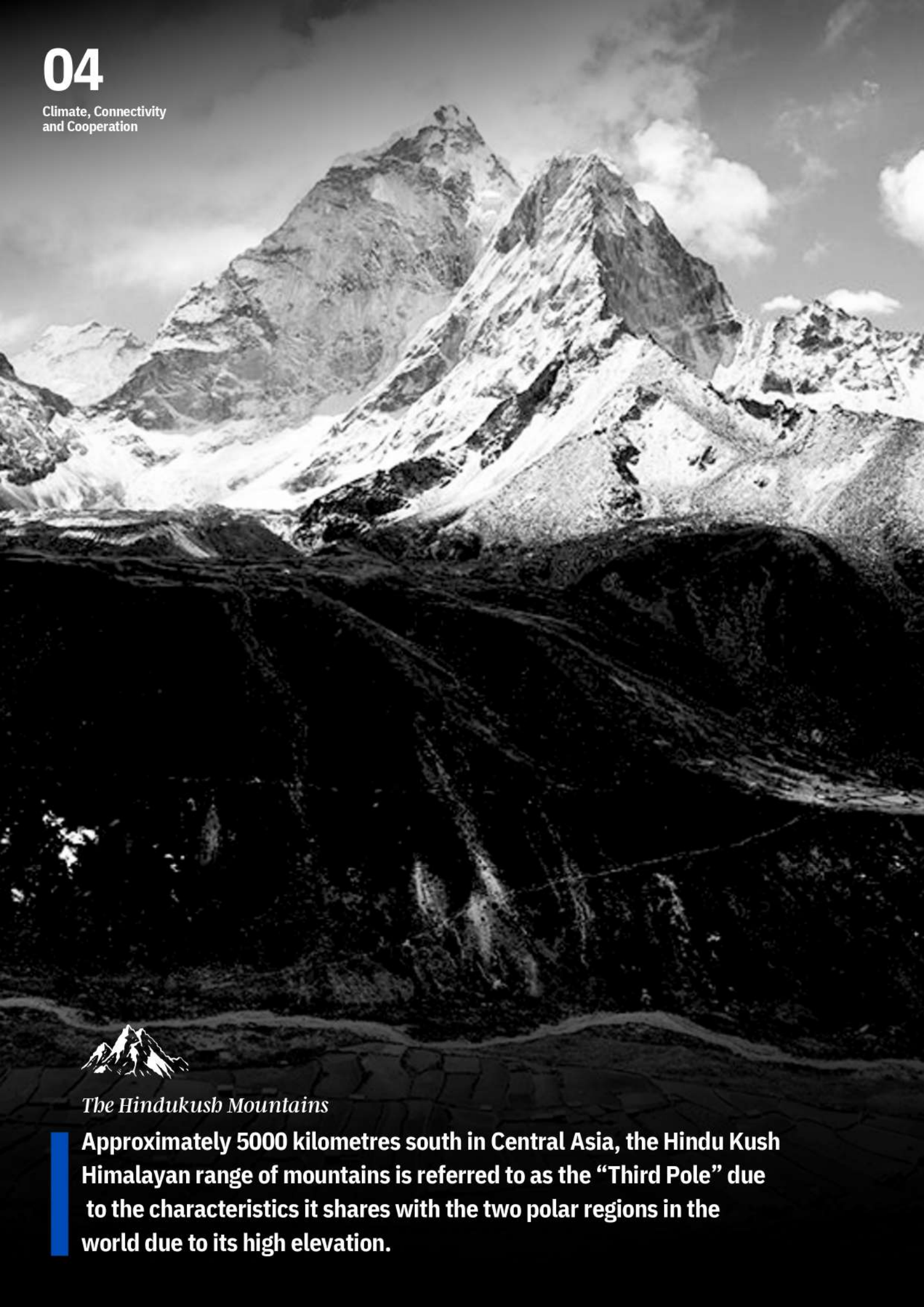
Climate, Connectivity and Cooperation



The Hindukush Mountains

Approximately 5000 kilometres south in Central Asia, the Hindu Kush Himalayan range of mountains is referred to as the "Third Pole" due to the characteristics it shares with the two polar regions in the world due to its high elevation.

Hindu Kush Himalayas– Nursery of Humanity

While the Arctic has garnered the due attention from the international community, its lesser-known sibling nestled between Russia and the Indian subcontinent, crowned with a bounty of geological features, still yearns for it.

Approximately 5000 kilometres south in Central Asia, the Hindu Kush Himalayan range of mountains is referred to as the "Third Pole"[2] due to the characteristics it shares with the two polar regions in the world due to its high elevation.

The system of mountains has sustained multiple civilisations; some of its glaciers and water bodies are sources for major river systems in the world such as the Ganga, Mekong, Brahmaputra, Amu Darya and Indus, to name a few, thus becoming the world's most crucial 'water tower'. Not only that, it is home to 4 global biodiversity hotspots and 210 million people spanning across 8 countries[3].The mountains act as an effective barrier for preventing harsh polar winds entering the Indian subcontinent and that has made inhabitation of a billion people possible.

However, most of them are vulnerable to poverty, food insecurity and climate change. Especially in the mountainous regions, lack of infrastructure as well as increasing pressure on its natural resources like freshwater and minerals make not only them more susceptible but also to those living downstream. A discourse has started building up on requisite policy interventions to facilitate climate action and engage local communities towards a more sustainable path to development.

Icebox

The Arctic, the northernmost polar region encircled by the Arctic Ocean, is also referred to as Earth's "icebox." It is well known for the Greenland Ice Sheet, permafrost, and vast quantities of sea ice.

The Melting Guardians of Climate in a Decade of Reckoning: Cryospheric Significance

The cryosphere is a fundamental element of our climate system, since it has a consequential impact on earth's water cycles, ocean circulation and even surface energy balance.

The term cryosphere acquires its nomenclature from the greek word "krios"[4] meaning cold. Cryosphere which refers to the frozen components of the earth, makes up about 10% of earth's total landmass. The entirety of snow cover, glaciers, ice sheets, sea ice and permafrost, altogether form the cryosphere. The cryosphere is a fundamental element of our climate system,[5] since it has a consequential impact on earth's water cycles, ocean circulation and even surface energy balance.

Two of the most important cryospheric zones on Earth are the Arctic and the Hindukush Himalayas, each of which plays a unique but related role in preserving the stability of the global climate. The Arctic, the northernmost polar region encircled by the Arctic Ocean, is also referred to as Earth's "icebox." It is well known for the Greenland Ice Sheet, permafrost, and vast quantities of sea ice. Whereas the Hindukush Himalayas also known as the "Water Tower of Asia[6]," span 3,500 kilometres through eight countries, from Afghanistan to Myanmar, and contain the most snow and ice outside of the polar regions.

The purpose of exploring these regions and their cryospheric importance extends far beyond the geographical boundaries as their rapid transformation due to climate change threatens the very stability of Earth's climate systems, biodiversity and even the livelihoods of billions of people, who depend on them. The Arctic is an essential part of the planetary climate regulation because of its role in controlling global temperature through ocean circulation patterns and albedo effects. Similar to this, the glaciers and snow reserves of the Hindukush Himalayas support the agriculture, hydropower production and domestic water supplies for nearly a quarter of the world's population by supplying freshwater services to about 2 billion people across 16 countries.[7]

United Nations

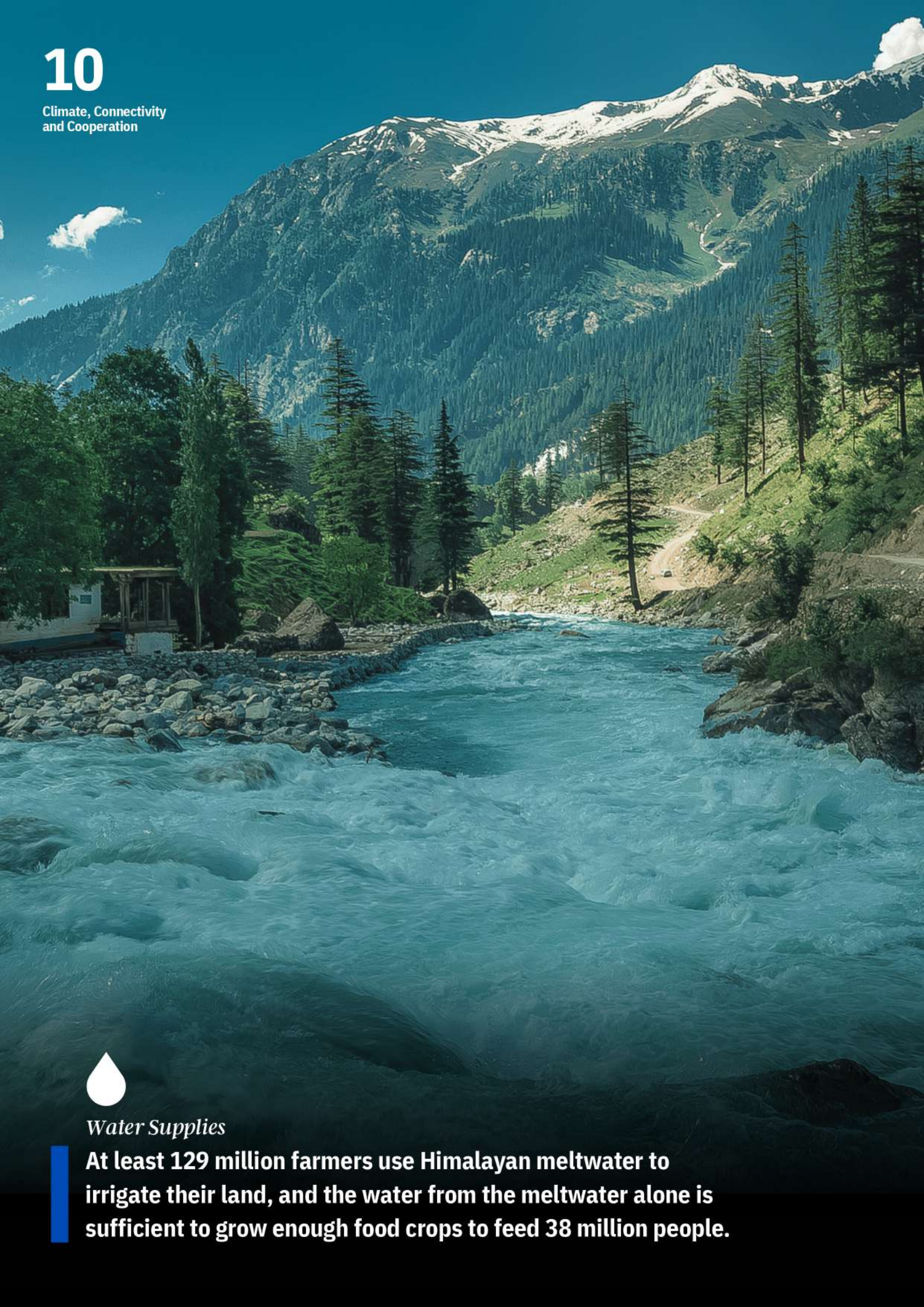
This historic initiative, introduced by France and Tajikistan and backed by over 30 countries, recognises that up to two billion people worldwide might not have access to enough food and water because of cryosphere changes.

In order to address the effects of climate change on billions of people worldwide, it is only imperative to comprehend the profound significance of these cryospheric regions as the entire world enters the United Nations Decade of Action for Cryospheric Sciences[8] (2025–2034), which is being led by UNESCO.[9] This historic initiative, introduced by France and Tajikistan and backed by over 30 countries, recognises that up to two billion people worldwide might not have access to enough food and water because of cryosphere changes. Together with the World Meteorological Organisation and other UN agencies, UNESCO has been designated as the primary agency to coordinate international efforts to advance scientific research and monitoring. This coordinated worldwide response reflects the growing recognition, that emissions from the permafrost alone could drastically lower the ability to sustain global warming to 1.5°C in the absence of immediate global mitigation efforts.

The Arctic Region: A Melting Planetary Thermostat

The Arctic has seen substantial physical changes since the mid-1980s, warming about three times faster than the global average since 1979. The vast amounts of sea ice, glaciers, and permafrost found in the Arctic region provide a phenomenon that is comparable to something like the Earth's natural refrigeration system. With an albedo of more than 0.8, the Arctic sea ice reflects over 80% of the sun's rays back into space. The melting of Arctic sea ice has already reduced the polar planetary cooling effect by as much as 15% since the 1980s. The albedo effect diminishes as the reflective ice is replaced by darker ocean water, resulting in a hazardous feedback loop that speeds up warming. Scientists predict that the first ice-free Arctic summer[10] could occur as early as in the 2030s or 2040s, marking an unprecedented event not seen in over 100,000 years.

In addition to accelerating climate change, the fast thawing poses a threat to Arctic communities and infrastructure, especially to indigenous groups who have evolved distinctive cultures tailored to these frozen environments. As evidenced by the Arctic Council's 2022 halt to operations in response to Russia's invasion of Ukraine, geopolitical tensions have also made any potential cooperation efforts more difficult.



Water Supplies

At least 129 million farmers use Himalayan meltwater to irrigate their land, and the water from the meltwater alone is sufficient to grow enough food crops to feed 38 million people.

As sea ice retreats, new shipping routes and resource extraction opportunities emerge but at what cost? Creating environmental risks. The region's transformation affects not only its sparse indigenous populations but also global climate systems, ocean circulation patterns and biodiversity.

The Hindukush Himalayas: World's Third Pole

For much of Asia, the Hindukush Himalayas are an essential source of freshwater. This massive mountain system is the source of ten major river systems in Asia that provide water to nearly 2 billion people. There are 240 million people living in the mountains themselves, and 1.7 billion downstream [11]. Recent research reveals alarming trends: the Hindukush Himalayan glaciers disappeared 65% faster in the 2010s than they did in the previous decade. The glaciers lost 0.28 meters of water equivalent per year between 2010 and 2019, compared to 0.17 meters in the previous decade. According to scientists, current emissions pathways will cause 80% of the current volume of glaciers to vanish by 2100.

For the Hindukush Himalayas, the idea of "peak water" is especially pertinent, which substantially describes the hydrological response of glacier fed rivers to climate change. According to glaciologist Miriam Jackson [12]accelerated melting will cause river water flow in the area to increase through 2050 before beginning to decline for the rest of the century. A crucial turning point for regional water security is this shift from rising to falling glacier runoff.

The ramifications are significant: At least 129 million farmers use Himalayan meltwater to irrigate their land, and the water from the meltwater alone is sufficient to grow enough food crops to feed 38 million people. These glacial sources are vital to major rivers like the Indus, Ganga and Brahmaputra, especially during the dry season when glacial melt supplies vital water supplies. The Himalayas are living, breathing ecosystems that sustain an incredible diversity of life far beyond their majestic snow capped peaks. The area is extremely valuable ecologically and is one of the 36 biodiversity hotspots in the world. The Himalayan Hotspot and the Indo-Burma Hotspot are two crucial biodiversity zones that are part of the Himalayan range in India alone.

Permafrost

The global stakes are highlighted by the ripple effects, which include the release of carbon from permafrost and water insecurity for billions of people.

They provide refuge to thousands of species, many of which are unique to this planet itself. The area is a mosaic of life, from delicate alpine flowers to old forests and from the quiet flight of snow leopards to the colourful calls of almost a thousand bird species. More than 10,000 vascular plant species, about 300 mammal species, and well-known animals like the Bengal tiger and red panda.

The Himalayas are even more unique because of the quick changes in the environment that occur within its elevation. A mere 190-meter[13] climb can drop temperatures by about one degree celsius. This suggests that in a relatively small area of land one can witness everything from tropical forests to the alpine meadows and even icy glacial zones. The remarkable diversity is the result of each of these layers providing a unique microhabitat to the region. Approximately 32% of the plant species found here are unique to this region. The Hindukush Himalayas serve as a reminder that biodiversity is more than just animals or lush forests; it is a complex system that sustains life, livelihoods, and cultures. It is both an ecological and a human responsibility to preserve them.

The Arctic region and Hindukush Himalayas represent Earth's most vulnerable yet globally significant cryospheric systems. The UN Decade of Action for Cryospheric Sciences, spearheaded by UNESCO, provides a never-before-seen framework for international collaboration to address the urgent problems facing these frozen regions. Time is running out to save these critical systems. Arctic summer sea ice may likely disappear within the next decade, and Himalayan glaciers are predicted to reach their maximum water levels in the coming decades. The global stakes are highlighted by the ripple effects, which include the release of carbon from permafrost and water insecurity for billions of people.

Ambitious scientific research and monitoring are necessary for success, but so is inclusive governance that tackles transboundary issues and strengthens the resilience of marginalised communities. The cryosphere serves as both an early warning system for climate change and a vital life-support system for the planet's health. Protecting these frozen protectors is not only local concern but also a global necessity for the welfare of future generations and the stability of Earth's climate.

Water Crisis

Experts also warn that if the acceleration continues to occur, it could trigger a severe water crisis, which has the potential to impact over 2 billion people across South Asia who depend on ice reserves.

Climate's Cold Collisions: Projected Impacts

Glaciers situated above 5,000 meters are no longer safe havens, but they too are shrinking, irreversibly.

The Glaciated Ranges of the Third Pole

Hindu Kush Himalayas are experiencing an alarming rise in glacier origin flood; these magnificent ranges could lose up to 75% of its ice by the end of the century if global temperatures continue to rise by 2%. The UN World Water Development Report[14] indicates that the retreat is 65 per cent faster than what it used to be in the preceding decade, and if warming exceeds 2 degree celsius, HKH could be robbed off of 45 per cent of its 2020 glacier volume[15] .Warming and melting trends are in turn impairing the hydrological systems [16]. In monsoon dominated regions, the soil runoff has increased and glacial lake outburst floods (GLOF) have become more frequent. In the Hindukush Himalayas, glacier floods have caused over 7,000 fatalities in the last 190 years, and it's projected to witness a three fold surge by the end of this century.

The International Centre for Integrated Mountain Development stated that a glacier lake at Purepu glacier, North of the Langtang Himal in the Hindu Kush Himalaya region has been subjected to rapid size shift. It further highlights that the region is highly vulnerable to the triple planetary crisis of climate change, pollution and biodiversity loss. Experts also warn that if the acceleration continues to occur, it could trigger a severe water crisis,[17] which has the potential to impact over 2 billion people across South Asia who depend on ice reserves.

One of the distinctive features exacerbating glacier threat in the Hindukush Himalayas is elevation dependent warming (EDW). As altitude increases, so does the rate of warming. This phenomenon is attributed to several reinforcing mechanisms, including reduced snow cover (and thus lower albedo), increased latent heat release from the water vapour and cloud dynamics. Glaciers situated above 5,000 meters are no longer safe havens, but they too are shrinking, more irreversibly.

Heating Up

This runaway feedback is a key driver of arctic amplification, the phenomenon where the arctic is heating up four times faster than the global average.

Climatic Shifts in the Arctic Region

Measurements[18] have proven that the Arctic has warmed quicker than the rest of the Earth– a phenomenon which is called “arctic amplification”[19] ,as a result of which permafrost is thawing at deeper levels which may have numerous repercussions. Firstly it causes erosion and subsidence, water bodies being drained leaving behind depressions. This not only changes the face of the Arctic but also has wider implications on the ongoing climatic ramifications. The permafrost stores huge amounts of carbon, and has twice as much as the atmosphere. This is because the icy layers contain dead plants, whose decomposition is prevented by low temperatures and low oxygen. Once the thawing occurs, microorganisms come into play, and break down these materials, releasing greenhouse gases. Arctic amplification is being reinforced by powerful feedback loops which are unique to this region; one of the most critical factors is the albedo effect. Albedo measures how much sunlight a surface reflects. Snow and ice which blankets most of the Arctic, reflects the sun's energy back into space due to high albedo. But as global temperature hikes, this reflective layer is colossally shrinking. In its place, darker surfaces such as the ocean and the bare ground are in exposure, absorbing far more heat than they reflect. This intensifies warming leading to rapid melting.

This runaway feedback is a key driver of arctic amplification, the phenomenon where the arctic is heating up four times faster than the global average. The dramatic decline in sea ice is a contributing factor. The heat absorbed by the newly exposed ocean doesn't just melt more ice, it also warms the surrounding atmosphere, speeds up permafrost thaw and accelerates glacier retreat. Recent plant ecology report positions the Arctic as a harbinger of biodiversity upheaval; over forty years across dozens of sites, scientists have recorded the greening of Tundra, as shrubs like willow migrate north and shade out lichens and mosses; which are critical ecological linchpins supporting caribou and human food systems.

Agriculture

These altered dynamics can trigger prolonged droughts or extreme precipitation events, with far and wide reaching consequences on agriculture, water resources and disaster risk.

Teleconnections in a Warming Cryosphere

Recent studies have found out that climate change doesn't work in isolation, but the repercussions induced on one region can ripple across others. Understanding these connections prove vital, as adaptation can be made smarter and more strategic.

Teleconnections exist [20] between the arctic and the third pole. Teleconnections refer to deep, often invisible threads that weave together distant corners of the planet through complex atmospheric and oceanic dynamics. In the intricate climate dialogue between the arctic and the third pole; these telecommunications act as conduits of climatic influences, transmitting the pulse of polar change thousands of kilometers southward. What happens in the rapidly warming Arctic does not stay confined to its icy frontiers, instead it cascades across hemispheres; reshaping weather systems, precipitation regimes and the very behaviour of glaciers.

One of the most immediate mechanisms of this connection is the reconfiguration of atmospheric circulation. Arctic warming alters the behaviour of the jet stream and planetary wave patterns, making them more erratic and sluggish. This disruption weakens the stability of traditional monsoon systems and reshapes the tracks of mid-latitude storms, leading to intensified or diminished rainfall patterns across South and Central Asia. These altered dynamics can trigger prolonged droughts or extreme precipitation events, with far and wide reaching consequences on agriculture, water resources and disaster risk.

Flood

Glaciers respond, not just to local conditions, but to these teleconnected forces, with melt rates accelerating and glacial lakes expanding, increasing the risk of outburst floods.

Another key pathway lies in the vertical interplay between the stratosphere and troposphere. The weakening of the stratosphere's polar vortex, which is a large-scale cyclonic system, can initiate shifts in atmospheric pressure that cascade downward and extend far south, even to the Himalayan region. This stratosphere-troposphere coupling can reshape weather behaviours in the third pole, influencing everything from seasonal temperature distribution to wind pattern. The ocean also serves as a vast medium for transmitting Arctic signals. As sea melts and freshwater enters the North Atlantic, the strength and stability of the Atlantic Meridional Overturning Circulation (AMOC) may be altered. This in turn affects the timing and intensity of South Asian monsoons, a lifeline for over two billion people. A weakened AMOC can delay monsoon onset, or reduce its strength, shifting rainfall away from its usual patterns straining water supplies across regions.

Finally, the atmospheric and oceanic shifts converge to reshape the hydrology of the third pole. Changes in temperature and precipitation alter snow accumulation, and the timing of the snow-melt. Glaciers respond, not just to local conditions, but to these teleconnected forces, with melt rates accelerating and glacial lakes expanding, increasing the risk of outburst floods. In this way, Arctic transformation becomes inseparable from the fare of the cryosphere in Asia. Synoptically, teleconnections are more or less like long-distance conversations that are profoundly shaping the future of water, weather and life across the roof of Asia.

Geopolitical Rivalries

Another challenge can be cited as China's ambitious geopolitical claims and stakeholdership over both the regions, escalating resource competition and geopolitical rivalries.

Geopolitical Dimensions

As both the regions stand at a significant yet fragmented geopolitical juncture with regards to global climate diplomacy, involvement of major environmental and economic councils and institutions

In the complex constellation of geopolitical altruism of current times, anthropogenic, demographic and environmental state of affairs provides a convergence point to both the regions to propose a model of cooperation. Ólafur Ragnar Grímsson [21],the founder of Arctic Circle, proposes research and science cooperation as a key to bridge the Arctic region with the Himalayas as both the regions have nearly opposite domestic governance models. The scientific observation, findings, methodologies and implications can be turned into a foundational stone of the diplomatic and political partnership between the two regions as it would also be capable of guiding regional decisions into a well structured domestic policy to mitigate the consequences of climate change and benefit the region demographically.

As both the regions stand at a significant yet fragmented geopolitical juncture with regards to global climate diplomacy, involvement of major environmental and economic councils and institutions such as the UN, COP, IPCC, Arctic Council, etc. become crucial to address the major gaps and formulate a coordinated climate response strategy.

One major geopolitical challenge faced by both the regions is Great Power Rivalry [22] and Militarisation which intensifies regional insecurity over time and hence posing a difficulty in formulation and implementation of designed policies. Another challenge can be cited as China's ambitious geopolitical[23] claims and stakeholdership over both the regions, escalating resource competition and geopolitical rivalries.

Local community

Local community must be an integral part of any policy that pertains to the conservation of these two regions.

Policy Recommendations

Effective management and equitable governance should be the core concepts of the mechanism. This would also open a new avenue of collaboration.

A. Local community must be an integral part of any policy that pertains to the conservation of these two regions.

B. It is time for nations, especially in the Hindu Kush Himalayan range, to allow for transnational collaboration on the preservation of ecosystems.

C. The evolving cryospheric interactions between the Arctic and HKH, exemplify the spatial rearticulation of climate dynamics in the Anthropocene. These connections call for a pivot away from regionalised frameworks to a systemic understanding of risk transmission. As climatic forcings increasingly transcend latitudinal and altitudinal boundaries, adaptive governance must account for multi-scalar interdependencies. The analytical and policy imperative then is to reconceptualise climatic ramifications as networked disruptions.

D. To solve the governance issues and promote sustainable development while countering degradation, Protected Area mechanism[24] must be introduced as a key strategy. Effective management and equitable governance should be the core concepts of the mechanism. This would also open a new avenue of collaboration between the two regions.

E. A confidence building mechanism should be built in a multilateral cooperation model linking all the major stakeholders as the members.

F. Inter-regional scientific collaborations and joint research programmes must be encouraged by the governments to identify the root problems and formulate a joint policy programme and pilot initiatives to work on it collaboratively by pooling in the required resources.

Earth

As the threat of climate change looms over the cold avenues of the Earth, it becomes more crucial for the world to collaborate and actualise their goals of mitigation.

G. Engagement treaty frameworks should be formulated between all the stakeholders and affected regions and governance forums to devise an impact assessment model in their regional circumference.

H. A deconfliction mechanism should be in place and should be monitored by neutral countries and organisations to keep check on escalating military tensions.

I. Trans-regional ambitions of the countries with expansionist policies should be assessed at every strategic point and the security infrastructure of these regions should be in place to counter such threat.

Conclusion

As the threat of climate change looms over the cold avenues of the Earth, it becomes more crucial for the world to come together.

As the threat of climate change looms over the cold avenues of the Earth, it becomes more crucial for the world to collaborate and actualise their goals of mitigation. With the common physical and demographic features, the Arctic and the Hindu Kush Himalayas a new partnership can be constructed with the geopolitical cooperation between the affected countries. An indigenous outlook of the increasing problems and an informed approach towards sustainability seems to be the best approach to move forward with the developmental practices for a secure, safe and sustainable world.

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- OCEAN TRACKER
- ARCTIC CENTRE
- WATER AND FOOD SECURITY
- SUSTAINABLE DEVELOPMENT STUDIES
- CENTRE FOR JUST ENERGY TRANSITION
- BIODIVERSITY AND CONSERVATION

Pillars of CREATION
For a Distinctly Indian Take on World Affairs

Pillars *of* CREATION

For a Distinctly Indian Take on World Affairs

The Geostrata, with a commitment to fostering a comprehensive understanding of global dynamics and thereby promoting a distinctly Indian take on world affairs, has structured its expertise into distinct pillars of creation. These pillars represent a synthesis of profound research, informed perspectives, and proactive engagement in each domain.

In our "Strategic Studies" division, we delve into critical issues ranging from national security challenges, such as aerospace threats and terrorism, to focused areas like maritime and cybersecurity. Recognizing the pivotal role of international relations, our "Diplomacy" pillar spans geographic-specific desks, ensuring we maintain a nuanced perspective on global interactions.

Our commitment to sustainable futures is evident in our "Environment" section, where we tackle everything from energy security to biodiversity conservation. Meanwhile, the "Trade and Development" segment ensures a comprehensive understanding of both global trade dynamics and intricate nuances of India's economic sectors.

The "History and Culture Desk" stands as a testament to our belief in the importance of understanding our past, rich cultural heritage, and linguistic diversities. With the rapid advancements in the technological sphere, our "Science and Technology" division remains at the forefront, analyzing developments from nanotechnology to AI.

Acknowledging the intricate weave of governance, our "Politics and Law" pillar delves deep into domestic and international legal frameworks and political landscapes. Similarly, the "Infrastructure" section focuses on the bedrock of urban and rural landscapes, ensuring we remain informed about key developmental facets.

Our endeavor to remain at the cutting edge is further cemented with our "Space Desk," where space exploration and technology come to the forefront. Lastly, our additional centers like the "Problem Identifier Center" and "Graphics Innovation Center" underscore our commitment to innovation, risk management, and holistic analysis.

Together, these pillars underscore The Geostrata's unwavering dedication to understanding and interpreting the world in its multifaceted complexity.

Team Pillars of Creation

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